FINNAPL IDIOM LIBRARY

SECOND EDITION

Jul. 13, 1982



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FOREWORD OF FIRST EDITION

The publication of this APL idiom collection was initiated by the FinnAPL Working Group of Programming Techniques in spring 1981, when good ways of teaching and promoting efficient use of APL were being discussed. It is a widely known fact that some idiom containing booklets and APL workspaces exist. However, the working group discovered several deficiencies in the usefulness of these sources: difficult and slow access, the relatively small amount of idioms and the tack of appropriate search methods. These arguments led to the decision of building a versatile, easy-to-use idiom library, from which any APL user can find practical tools for daily work. The goal of this publication is to promote good and efficient APL usage by means of APL idioms, and facilitate and speed up APL programming.

The first and most important source of idioms has been the Working Group itself - the experience and everybody's own idiom reservoirs. The members of the group are:

Arto Juvonen Seppo Kaltio Timo Kunnas

Timo Laurmaa

Heimo Penttinen

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Helsinki University of

Technology

Bank of Helsinki

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Tauno Ylinen Ministry of Finance

Also the following publications were very useful:

A.J. Perlis, S. Rugaber:

Programming with Idioms in APL, APL Quote Quad, vol. 9, no. 4, 1979

K.E. Iverson:

Notation as a Tool of Thought Communications of the ACM, vol. 23, no. 8, August 1980

O.I. Franksen:

Computing - An Economy of Thought NordDATA81, Copenhagen 1981

R.P. Polivka, S. Pakin:

APL: The Language and Its Usage Prentice-Hall, 1975

R.A. Smith

A Programming Technique for Non-rectangular Data, APL79 Conference Proceedings, ACM.

The Finnish APL Association is pleased to receive any comments and new idioms in order to increase the versatility and quality of this idiom library.

FOREWORD OF SECOND EDITION

The second edition of the FinnAPL Idiom Library differs from the first one in several aspects: the number of idioms has been increased from 452 to 631, most of the idioms have been tested with a computer, many errors have been corrected, some explanations have been made easier to understand, and a function-based index has been included. The publication is also introduced in a more compact version (FinnAPL Pocket Idiom Library).

The working group for this edition has been:

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FinnAPL wishes to thank for the numerous contributions by APL users from several countries, and is still pleased to receive comments and new idioms to help in developing future editions of the library.

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THE USE OF IDIOMS IN APL

Arto Juvonen TMT-Team

1. INTRODUCTION

Idiom is a speech form that is peculiar within the usage of a given language. In APL, an idiom is a meaningful primitive structure constructed from primitive functions. Idiom is characterized by ease of recognition, frequency of occurrence and flexibility in use. Due to APL's conciseness and functional nature the language contains a large number of useful idioms, whose familiarity makes the programming effort more efficient and unravels programs made by others.

An idiom is an APL primitive construct like the APL primitive and derived functions because of its presence in the language. However, an idiom has a special connotation, that cannot be directly derived from its constituents. Once the idiom is learned, the meaning can be perceived from the program line without analyzing the structure function by function. Let us take as an example the 'if'-idiom I'l in a conditional branch statement. Due to the expression →LINE[\COND the program branches to line LINE, if COND (1 or 0) is true. Otherwise execution continues at the next The expression might be difficult to line. decipher, if the idiom is not familiar. After learning the behavior of the idiom the use and understanding of it is trivial.

One of the main characteristics of an idiom is its conciseness. It is easy to remember and recognize and quick to type. Because of this it is not necessary to define an idiom as a function, although this is quite common. Idioms are often more useful as part of another expression. By writing the idiom straight to the function line the naming problem can be avoided. A person acquainted with the idiom does not have to know in which workspace and with which name the expression is saved, and does not have to copy the function into the workspace. Also the problem of having a different object of the same name in the workspace can be avoided. Moreover, the reader of the program does not have to recognize the name. It is also useful to use idiomatic expressions in the library subroutines instead of the equivalent

defined functions to avoid chained calls and thus group definitions or copying of defined library functions one by one during the first application programming test run.

The difference between an idiom and a defined function can easily be seen. An important difference is their length. Idioms are almost always expressed naturally in one line. A defined function may contain more complicated, e.g. iterative structures. If an idiom is embedded in a defined function, it is useful to write it in a general form to allow wider use. Thus in a defined function the idiom is hidden in the jungle of shape and reshape functions that guarantee the compatibility of the arguments. If the idiom is written as part of the function line, the simplest form according to the current arguments can be used. There are also idioms that cannot be written as a function because of the great number of arguments or some other special feature. Such idioms are e.g. templates, that can be used to create new idioms.

2. THE USE OF IDIOMS IN WRITING AND READING PROGRAMS

No language contains a perfect set of functions for every need encountered in solving problems. APL idioms can often be used as APL primitive functions. They make the language more expressive and bring the language nearer to the human thought structures. Idioms act as an intermediate language in man-machine communication. Thus, mastering a group of basic idioms is necessary for efficient APL programming allowing the lines to be written from left to right and not a function at a time from right to left.

Idioms act also as a means of convaying thoughts between the program writer and the reader. Understanding a program is a discontinuous process. The meaning of a line is first unclear. After initial research the reader can make a hypothesis of the meaning. Additional studying verifies the model. Insight is more easily attained if the program writer and reader share a large number of idioms. Not knowing the idiom written by someone else interrupts understanding of the program flow. The reader can study the result of functions applied to sample arrays element by element, but making a hypothesis of the meaning of the expression may be very difficult.

Thus both in writing and reading programs

mastering a large set of idioms is an invaluable tool. Idioms should be learned early while tearning other language fundamentals, as this helps to organize the students understanding of the numerous possibilities of the primitive functions and their combinations. Idioms are best learned by encountering them in different environments and by using them. New idioms can be found by using one-line solutions, as this helps avoiding splitting of data and thought.

3. EXAMPLES OF IDIOMS

Idioms can be classified for example in the following manner:

- 1. Structural
- 2. Sorting
- Searching
 Tests
- 5. Forming boolean vectors
- 6. Text processing
- 7. Numerical
- 8. Object generators
 9. Subvector processing
- 10. Templates

Changing the structure of an array is common because of the compatibility requirements of functions. A typical example is forming a vector into a one line matrix V+(1,pV)pV or a 'column vector' V+&(1,pV)pV. A numeric vector can be reshaped also with the idiom V+V•.+,0. Often operating with higher dimensional arrays may be cumbersome. E.g. multiplying an array A of shape k,m,n with array B of shape k,m, L,n so that the elements along the second axis of A are also used for multiplying the elements along the third axis of B necessitates forming a new axis in A after the second axis. The new axis is first shaped to contain a dimension of length one. The dimension is replicated I times by indexing: S+(1,pA)[2 3 1 4]pA and S+S[;;(pB)[3]p1;]. array is restructured often by the transpose function TQA. The element T[I] specifies, where the i:th axis of the argument array will be located in the resulting array. Thus forming a new axis after the i:th axis and replicating it n times can be generally stated with the idiom

Sorting arrays is based on the grade primitive function 4. The task of idioms is to create suitable numeric arguments for the grade function.

For example a word list can be sorted with the idiom I+4(pA)±QAIM, where A contains the alphabet used and M the words to be sorted. By using this idiom a sorting of 8 to 10 columns can be performed at a time. Sorting a wider matrix or taking other factors into consideration requires sorting to be started with the least significant sorting factor and indexing the next factor with the resulting grade vector. E.g. forming the grade vector I by using the first two columns of a numeric matrix M would be performed by using first the second column I+4M[;2] and then the first one I+I[4M[I;1]].

Often we have to sort numeric codes in vector A to the corresponding sequence S e.g. for summing. The required grade vector can be formed with the idiom I+4S\A. A[I] can be used to get the lengths of the subvectors to be summed.

Searching is often based on location function (1) or compression of indices L/1pL. The location function can be used e.g. to locate the index of the first positive element in vector V: (V)0)11 or the index of the first occurrence of vector A in matrix M: $(M\wedge .=A)11$.

Test idioms are very frequent. Good examples are the test of numericity of an array A: $0 \in 0 \setminus 0$ pA, and the test of emptiness: $0 \in pA$, and the test of equalness of all elements in vector A: $\triangle A = 1 + A$.

Forming a modification of a logical vector is often fundamental when using the APL way of solving problems. E.g. the following transformations can be performed to a logical vector (array):

Turn on all 0's after the	fir	5	t t	i		
	Θ				0	1
V\L 0	0	1	1	1	1	1
Leave on the i's preceding	th	e	f)" <u>:</u>	s t	0
	1					
A\L 1	1	Í	0	Θ	0	0
Leave on only the first 1						
L← 0	0	1	0	1	1	1
⟨\L	Θ	1	0	0	0	0
Create a vector of running	ev	(6)	n p	aı	r i f	ty
Le- 1					Θ	
#\L 1	1	1	0	1	1	0

Leave on the first 1 on each group of 1's L← 0 1 1 0 1 1 1 L>1+0,L 0 1 0 0 1 0 0 Generally L>((-ppL)↑1)+0,L

Leave on the first group of 1's

L← 0 1 1 0 1 1 0

L∧∧\L=∨\L 0 1 1 0 0 0 0

Leave on the groups of 1 in B indicated by the corresponding 1 in vector L

L

0 1 0 0 0 1 0 1

B

1 1 1 0 1 1 0 1 1

B

AE(L

B)/A++\B)-1+0,B 1 1 1 0 0 0 0 1 1

Text processing often aims at finding a character or a character string satisfying given conditions. Because APL primitive functions use a character as an element, the text and word processing area contains many idioms to perform higher level operations. Some examples are deletion of blanks from a character vector V: (V#' ')/V, deleting leading blanks ($\vee \vee \vee \neq '$ ')/V and trailing blanks: ($^{\uparrow} \uparrow (\vee \neq '$ ')/ $^{\downarrow} \lor)$ /V. Replacing each element A in vector V with B: $\vee [(\vee = A)/(\rho \vee)] \in B$ is simple, and the idiom $V[L/1pL]+B[(L+I\leq pA)/I+A1V]$ can be used, if A and B are vectors. The occurrences of vector A in vector V can be located with the idiom I+(V[Io.+-1+10A] .= A)/I+(I=1 A)/10 I+(1-0A) V. In it the possible starting locations are found by the initial letter and the length of A. The substrings of V starting from these indices are compared with A.

Vectors are often the most convenient way to handle data because of flexible selection and indexing. A vector is often divided into variable length parts (subvectors) that must be operated on analogously. In the following examples a boolean vector P indicates the partitioning of the argument vector.

P+1 0 0 0 1 0 1 A+1 2 3 4 5 6 7 and L+1 1 0 1 0 0 1

The lengths of the parts $Z \leftarrow Z \leftarrow 1 + 0$, $Z \leftarrow (1 + 0) / 1 + 0$ 4 2 1

The sum of the elements of parts in A $Z\leftarrow Z\leftarrow 1 \downarrow 0$, $Z\leftarrow (10P)/+\A$ 10 11 7

The or-reduction of the parts in vector L $Z \leftarrow (P/L) \ge Z/1 \varphi Z \leftarrow (P \lor L)/P$ 1 0 1

A template is a model that can be used to create useful structures. In the following templates a stands for a suitable function or another idiom. Template (pA)pA, A means raveling array A, operating on it and reshaping it back to the original shape. By using this template and a suitable idiom we can e.g. change the elements A in array S to B: V[(V=A)/1pV+,S]+B and S+(pS)pV.

Using numerical calculation instead of conditional branching is often useful. E.g. idiom (XxB)+Yx~B can be used to select an element from X if the corresponding element in B is true, otherwise from Y. The Idiom Xx1 "1[B+1] can be used to negate the elements of X indicated by B.

The template ANB*.«C encourages to use outer product to compute all needed combinations and to select the needed ones with the diagonal transpose... For example adding the vector X to the columns of matrix M can be performed with the idiom i 1 29X*.+M.

HOW TO USE THIS IDIOM LIBRARY

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1. THE PARTS OF THE IDIOM LIBRARY

1.1 Idiom List

The library is based on an idiom list containing 631 APL idioms. Every idiom consists of an APL expression, a brief verbal description, the description of arguments and parameters, and an index number. The list is sorted in a 'functionally alphabetical' order; therefore two very similar idioms will not be far from each other. The functionally alphabetical order is based on the order of functions listed in the Table of Functions so that e.g. expressions containing 4 are found in the beginning of the list and so on.

The argument description states the requirements set to the variables in the expression (arguments or parameters). The most common requirements include information of the rank or shape of the array as well as the type, according to the following rules:

- Naming convention of data objects:
 - -- X,Y arguments
 - -- G,H parameters
 - --- A,B intermediate results etc.
- Data type expressions (in argument descriptions):
 - -- C = character
 - -- B = logical (boolean)
 - -- I = integer
 - -- D = any numeric data type
 - --- A = any data type, no limitations
- Representation of the ranks of arrays:
 - -- 0 = scalar
 - --1 = vector
 - 2 = matrix
 - -- = (empty) no limitations; the shape is mentioned separately, if necessary
- Examples
 - -- XED2 argument X is a numeric matrix
 - -- GeIO parameter G is an integer scalar

1.2 Permuted index

The bulk of this idiom library consists of an alphabetical index sorted according to a so-called permuted index (keyword in context) method. This method is used in order to facilitate finding appropriate idioms with the assistance of typical keywords. A verbal description with n words will usually occur in n places in the index, at the place of each word of the description. This provides an easy way to find a suitable idiom even if its description is not completely known. The index contains a reference to the index numbers in the idiom list. If a description corresponds to two idioms with numbers clearly unequal, it is likely that the desired result can be achieved with two highly different solutions (nearly equal numbers would indicate similarly built expressions).

1.3 Synonym List

Same results can be achieved in several different ways in APL. This list is a collection of certain idioms from the idiom list that perform (at least approximately) similar operations. (They may differ from each other for instance by requirements set for their arguments.) The synonym list gives a good insight of how to produce similar results in many different ways in APL. Studying these differences will certainly help widening the understanding of APL idioms and expressions.

2. LIMITATIONS OF THE IDIOM LIBRARY

APL idiom library has been designed for the most common programming circumstances. Consequently, some idioms will not work as desired in every special situations. The idioms will generally work with at least the default values of a VS APL empty workspace, which usually apply also in application workspaces. Possible circumstances for unexpected behaviour of certain idioms might be for instance

- OPP+4 Printing precision is small - OCT+0.1 Comparison tolerance in high

The index origin DIO deserves special consideration. As the default value is one, every idiom (unless the description states differently) will work if DIO = 1. Several idioms include DIO in the APL expression, which means that the idiom works with both possible DIO values. Exception

cases (works only if DIO = 0) are reported separately in the verbal description. The great majority of the idioms will work in the expected way, independent of parameter values.

This publication intends to present only efficient idioms that promote good APL programming style. It is, however, sometimes difficult to decide if an APL expression will be efficient in every situation. Therefore, especially in handling very large data objects there is a danger that huge amounts of cpu time will be spent or that a WS FULL occurs unexpectedly. If the idiom is good in principle ((X\X)=\pX is a typical example), but in some conditions may turn out to be inefficient, this is mentioned in the verbal description. Avoiding WS FULL problem is possible for instance with the thumb rule stating that the outer product . may easily cause a WS FULL if large data objects are being handled.

Some idioms include numeric or character constants which make the idioms more recognizable but seem to reduce their generality. For instance, the idiom DIVIDING A 400×12 CHARACTER MATRIX INTO ONE PAGE contains the constants 400 and 12, which clearly have to be modified according to the column width and page length.

Certain idioms contain the delta function A needed when chaining expressions. If these idioms are used, the workspace should contain this function defined in the following way:

This function causes the rightmost expression to be processed first. The leftmost expression will then be executed independently of the result of the previous one.

3. EXAMPLES OF THE USE OF THE IDIOM LIBRARY

3.1 Finding an idiom to perform a desired task

If we want to use the idiom library to find an expression that underlines a text vector, we can examine words UNDERLINE, TEXT and VECTOR in the index. If the desired idiom belongs to the library, some of these key words will very likely be found in the index. As related idioms are described as UNDERLINING A STRING and UNDERLINING

WORDS, key word UNDERLINING will show where a suitable idiom can be found.

3.2 How can decode T be used

Because the idiom list is sorted according to a functional order, most idioms using T are grouped in the same part of the list, near its beginning. Studying idioms in this way will help tearning new ways of applying APL functions and thus widen the APL way of thinking.

3.3 Removing duplicate lines or elements

The index part contains several idioms under the keyword DUPLICATE. These idioms have been collected to the synonym list. By comparing these idioms it is possible to find an expression that will work properly and efficiently in the desired situation, like finding different words from a word matrix.

3.4 What does expression A.+,0 do

Idioms based on the outer product can easily be found in the idiom list. The verbal description of idiom X*.+,0 shows that this is a way to form a one-column matrix from a vector.

TABLE OF FUNCTIONS

```
1 ...
       37
                GRADE UP A
       44
                GRADE DOWN V
 38 ...
 45 ...
        63
                ENCODE T
 64 ...
                DECODE 1
        84
85 ... 101
                EXECUTE +
                FORMAT #
102 ... 111
112 ... 120
                BRANCH +
                ROLL / DEAL ?
121 ... 123
                MATRIX INVERSION / MATRIX DIVISION III
124 ... 128
129 ... 134
                GEOMETRICAL O
135 ... 142
                FACTORIAL / BINOMIAL
143 ... 204
                OUTER PRODUCT ...
205 ... 246
                INNER PRODUCT ...
247 ... 310
                SCAN WI WY
                REDUCTION w/ wf
311 ... 374
375 ... 412
                TAKE +
413 ... 448
                DROP +
                CEILING / MAXIMUM [
449 ... 449
450 ... 462
                FLOOR / MINIMUM L
463 ... 479
                MAGNITUDE / RESIDUE |
480 ... 490
                EXPAND \
491 ... 513
                COMPRESS /
                TRANSPOSE &
514 ... 527
528 ... 537
                REVERSE / ROTATE & O
538 ... 548
                MEMBER OF €
                INDEX GENERATOR / INDEX OF &
549 ... 563
                LOGICAL ~ V A Y A
564 ... 569
570 ... 575
                COMPARISON < \le = \ge > *
                RAVEL / CATENATE .
576 ... 598
599 ... 609
                AXIS / INDEXING [
                SHAPE / RESHAPE
610 ... 618
                ARITHMETIC + - × +
619 ... 628
629 ... 631
                MISCELLANEOUS
```

IDIOM LIST

	GRADE UP A	
1	l.5×(ΔΔΧ)+ΦΔΔΦΧ Ascending cardinal numbers (ranking, shareable)	X+D1
2	$Y[A_1[A+AA[A(+X)[A+AY]]]$ X+B1; Maximum scan ([\) over subvectors of Y indicated by X	Y+D1
3	$Y[A_1[A+AA[A(+X)[A+Y]]]$	Y+D1
4	Y[AY]^.=X[AX] Test if X and Y are permutations of each other X+D1;	Y+D1
5	$X[A[A(+(ipX)\epsilon+(DIO,Y)[A+AX]]]$ $X+Di; Y+Ii; (pX) + Sorting subvectors of lengths Y$	+/}
6	$Y[A[X/\Delta(+\backslash X)[A+\Delta Y]]]$	
7	A[\$(+\X)[A+\$Y]] X+B1; Grading up subvectors of Y indicated by X	Y+D1
8	$(pX)p(,X)[\Box IO+A[\Delta A+T1+pX]]$ Δ $A+(\Delta,X)-\Box IO$ Sorting rows of matrix X into ascending order	X+D2
9	(pX)p(,X)[A[\$(,\$(\$pX)piitpX)[A+\$,X]]] Sorting rows of matrix X into ascending order	X+D2
10	$(\Delta\Delta(G+1), \iota\rho\rho X) \Phi(Y, \rho X) \rho X$ G+I0; Y+I0 Adding a new dimension after dimension G Y-fold	; X+A
11	$(Y,X,Z,)[\Delta\Delta G]$ $X+Ai; Y+Ai; Z+Ai;;$ Merging X, Y, Z under control of G (mesh)	G+7 i
12	(X,Y)[\$\$G] X+A1; Y+A1; Merging X and Y under control of G (mesh)	G+B1
13	ΔΔΧ Ascending cardinal numbers (ranking, all different)	X+D1
14	Y[A[X/\$(+\X)[A+\formuY]]] X+B1; Maxima ([/) of elements of subvectors of Y indicated by	
15	$A[\Delta(+\backslash X)[A+\forall Y]]$	Y+D1
16	(Y,X)[A\VG] X+A1; Y+A1; Merging X and Y under control of G (mesh)	G←B1
17	ΔΨΧ Descending cardinal numbers (ranking, all different)	X+D1

18	X[\$(1+pY)1Y10X;] X+A2; Sorting rows of X according to key Y (alphabetizing)	Y+A1
19	X[&+fA <qa+x,0;] a="" into="" lexicographic="" matrix="" order<="" sorting="" td=""><td>X+D2</td></qa+x,0;]>	X+D2
20	X[\(\Lambda X \)]^.=\pX Test if X is a permutation vector	X+11
21	Y[AX++\X] X+B1; Rotate first elements (14) of subvectors of Y indicated	
22	1+AX Index of (first) minimum element of X	X+D1
23	T1+&X Index of (first) maximum element of X	X+D1
24	X[(AX)[[.5×ρX]] Median	X←D1
25	(X,'''')[([]/O+pX)[&(\pX),(''''=X)/\pX] Doubling quotes (for execution)	X+C1
26	$(X,'*')[(\Box IO+\rho X) \downarrow \& (\iota \rho X), (Y \times \rho G) \rho G]$	G+11
27	$(\rho X) \ge \Delta(\iota \rho X), Y$	Y+11
28	(X,ApH)[\$(\pX),ApY] \(\Delta \text{A+G*p,Y} \) Catenating G elements H after indices Y in vector X	H+A0
29	((ApH),X)[A(ApY),1pX] A A+G×p,Y X+A1; Y+I1; G+I0; Catenating G elements H before indices Y in vector X	H+40
30	AYtX Grade up according to key Y	X+A1
31	A \(A[\Delta G] + A + Y , X \\ Merging X and Y under control of G (mesh) \\ X + A1; Y + A1; \(Y + A1; \)	G+B1
32	X[AY[X]] X+I1; Sorting indices X according to data Y	Y←D1
33	X[AX[;Y];] Sorting a matrix according to Y:th column	X+D2
3 4	AXx ⁻¹ i[Y] X+D1; Choosing sorting direction during execution	Y+10
35	X[AX] Sorting X into ascending order	X+D1

36	Y[AX] Sorting Y according to X	+A1;	Y+A1
37	AX Inverting a permutation		X+I1
	GRADE DOWN *		
38	X[V+fA <qa+x,0;] a="" into="" lexicographic="" matrix="" order<="" reverse="" sorting="" td=""><td></td><td>X+D2</td></qa+x,0;]>		X+D2
39	X[Φ♥+\(ιρX)ε+\[IO,Y] Reversal (Φ) of subvectors having lengths Y	+D1;	Y+I1
40	Y[OV+\X] Reversal (0) of subvectors starting at indices X	+B1;	Y+A1
41	(+/X)†♥X Indices of ones in logical vector X		X+B1
42	X[†' '*X] Moving all blanks to end of text		X+C1
43	X[VY] Moving elements satisfying condition Y to the start	+A1;	
44	X[VX] Sorting X into descending order		X+D1
	ENCODE T		
45	¥101((1+[2•[/,X)p2)TX Binary format of decimal number X		X+10
46	1 0*10 10T1-[][O-1X Helps locating column positions 1X		X+10
47	$\Phi((0,\iota\rho X)\cdot .=+f\sim A)+.\times(-X)\times.*A+((\rho X)\rho 2)\tau^{-1}+\iota 2*\rho X$ Polynomial with roots X		X+D1
48			X+D2
49	<pre>0'0123456789ABCDEF'[□IO+(([[/16⊕,X)p16)TX] Conversion from decimal to hexadecimal</pre>		X←I
50	(,X)/1+ATT1+1×/A+pX Transforming connectivity matrix X into a connectiv	ity :	X+C2 tist
51	□IO+(pX)T(\×/pX)-□IO Matrix of all indices of X		X+A

52	(([201+X)p2)T0,tX All binary representations up to X (truth table)	X+10
53	((1+l10@X)p10)TX Digits of X separately	X+10
54	((1+ Y⊕X)pY)TX Representation of X in base Y	Y+D0
55	□IO+(ρX)τ(-□IO)+(,X∈Y)/ιρ,X Indices of elements Y in array X	; Y←A
56	,' ',q'0123456789ABCDEF'[[]IO+16 16T-[]IO-[]AV:X] Conversion of characters to hexadecimal representation	X+C1 ([]AV)
57	Φ(3 _P 100)τX Separating a date YYMMDD to YY, MM, DD	X+D
58	□IO+(X,Y)T(\(\frac{1}{2}\times Y\)-□IO X+10; All pairs of elements of \(\frac{1}{2}\times And \(\frac{1}{2}\times Y\)	Y+10
59	((pX)p2)T ⁻ 1+12*pX Matrix for choosing all subsets of X (truth table)	X+A1
60	$(X\rho 2)\tau^{-}1+\iota 2*X$ All binary representations with X bits (truth table)	X+10
61	1+YTX X+D; Incrementing cyclic counter X with upper limit Y	Y+D0
62	0 1τX Integer and fractional parts of positive numbers	X←D
63	10 100 1000τX Decoding numeric code ABBCCC into a matrix	X+1
mu .m	DECODE 1	
64	A \triangle A[3 6]+':' \triangle A+ \mp 1000±3+3+ \square TS Representation of current time (24 hour clock)	
65	A ∆ A[5 8]+'-' ∆ A+∓100013†□TS Representation of current date (descending format)	
66	→Y[1+21X] Y+11; Case structure with an encoded branch destination	X+B1
67	GLYEX* Φ -DIO-LpX Interpolated value of series (X,Y) at G X+D1; Y+D1;	G+D0
68	' ±0⊕'[□I0+2±X•.≥\[/,X] X+I2; 1ppX Barchart of two integer series (across the page)	↔ 2

69	$(X \cdot . + , 0)$ LY $X + D1$; $Y + D1$ Value of polynomial with coefficients Y at points X
70	((A:A)=:pA+21X^.=QX)fX Removing duplicate rows
71	BpA \triangle A[\square IO+B[1]±- \square IO-X]+1 \triangle A+(×/B+0 0+f/,X)p0 X+C2 Transforming connectivity list X into a connectivity matrix
72	1001100 3† TS Encoding current date
73	(1-(' '=X)11)+X Removing trailing blanks
74	(12p7p31 30)[X]-0[$^-$ 1+21(X=2),[.1]0 $^{\pm}$ 4 Y X+10; Y+1 Number of days in month X of year Y
75	161-\[IO-\]0123456789ABCDEF\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
76	(1-(' '=X)11) ΦX X+C Justifying right
77	(+1+Y+100)1¢X X+D1; Y+D0 Present value of cash flows X at interest rate Y %
78	101-1+10123456789'1X X+C1 Transformation of alphanumeric string into numeric
79	(' '=X)11 Index of first non-blank, counted from the rear
80	(,X)[\BIO+(\rho X)\pm \Indexing scattered elements \times \text{X+A; Y+I2}
81	□10+(pX)1Y-□10 X+A; Y+12 Conversion of indices to indices of raveled array
82	(1+Y+100)1X Future value of cash flows X at interest rate Y % X+D1; Y+D0
83	X1Y Value of polynomial with coefficients Y at point X X+D0; Y+D
84	21X Integer representation of logical vectors
	EXECUTE ±
85	<pre>t±'1','++'[□IO+^/(ρX)=ΦρX],'''0~0εX=-ΦX''' Test for antisummetricity of matrix X</pre>

X+D1; Y+A2

86	±±'1','†+'[□IO+^/(ρX)=ΦρX],'''0~0εX=ΦX''' Test for symmetricity of matrix X
87	{10⊕(±('.'≠A)/A+¥X)÷X Number of decimals of elements of X
88	±'VAR',(\(\forall X\)),'+Y' Using a variable named according to X
89	±X/'→' Conditional branch out of programs
90	' *'[\Box 10+(Φ ($^-$ 1+ \bigcup 1A)+ \bigcup 1+(\bigcirc 1A)+.=A+ \bigcup 1.5+ \triangle F} F+A1; X+D1 Graph of F(X) at points X ('X' \in F)
91	$A+.\times\pm F,0$ p $X+Y[1]+(A+/Y+G)\times 0,1G$ $F+A1;$ $G+D0;$ $Y+D1;$ $pY\leftrightarrow 2$ Definite integral of $F(X)$ in range Y with G steps $('X'\in F)$
92	$X+\pm$,((2†'X'),' ',[.5]A)[$\Box IO+\sim$ ' ' \wedge .= $A+$, \Box ;] Changing X if a new input value is given
93	(Xv. *' ')\1+±'0 ',,X,' ' Conversion of each row into a number (default zero)
94	±((X∧.=' ')/'Y'),X X+D1 Converting expression X to numeric form with default value Y
95	1+±'0 ',(∧/X∈' 0123456789')/X X+C1 Test if numeric and converting into numeric form
96	±X/'EXPRESSION' X+B0 Conditional execution
97	1p(±0,',10'),X X+D0 Giving a numeric default value for input
98	A+±,',','(','0','p',Y,'+',X,')' X+C2; Y+C2 Assign values of expressions in X to variables named in Y
99	±,',','(',',X,')' Evaluation of several expressions; results form a vector
100	±'X[',((~i+ppX)p';'),'Y]' X+A; Y+I Indexing when rank is not known beforehand
101	£,'+',X Sum of numbers in character matrix X
	FORMAT ¥

Numeric headers (elements of X) for rows of table Y

102 (3¢7 0∓X+.+,0),∓Y

103 ¥X+.+,0 X+D1 Formatting a numerical vector to run down the page $A \triangle A[(' '=A)/1pA]+'.' \triangle A+\mp 03+\square TS$ 104 Representation of current date (ascending format) 105 $(,(0\ 1 \downarrow 3\ 0 \mp 100 + 3\ 1 \rho 12\ 0\ 0 \mid 3 \uparrow 3 \downarrow \Box TS),':: '),'AP'[1 + 12 \leq \Box TS[4]],'M'$ Representation of current time (12 hour clock) X+11; Y+10 106 0 1+(2+Y+1)*(10*Y)+((pX),1)pXLeading zeroes for positive numbers X in fields of width Y $A \triangle A[(' '=A)/\iota \rho A] \leftarrow '/' \triangle A \leftarrow 100|103 + \square TS$ 107 Representation of current date (American) 108 $(\rho A)\rho B \setminus (B \leftarrow, ('0' \neq A) \lor ' \neq 1 \Phi A) /, A \leftarrow ' , \mp X$ X+AFormatting with zero values replaced by blanks 109 $((1,G)\times \rho X)\rho = 1 \quad 3\phi(\phi G,\rho X)\rho(,G,[1.1]Y)\mp \phi X$ X+D2; Y+11; G+10 Row-by-row formatting (width G) of X with Y decimals per row 110 $(G,G,[1.1]H) \neq X$ X+D: G+I1: H+I1 Formatting X with H decimals in fields of width G 111 $\rho \mp X$ X+D0 Number of digit positions in scalar X (depends on $\square PP$) -BRANCH + 112 $+\Box LC[iv], (X+XvXv,AX) \neq +X$ X+B2 Forming a transitive closure 113 $\rightarrow Y [\iota G \ge X + X + 1]$ X+10; Y+10; G+10 For-loop ending construct 114 →Y[\X X+B0; Y+10 Conditional branch to line Y 115 →X/Y X+B1; Y+I1 Case structure with logical switch (preferring from start) 116 →XΦY X+10: Y+11 Case structure with integer switch X+A0; Y+I1; G+A1 Case structure according to key vector G 118 →0×1X X+80 Conditional branch out of program 119 →Y[2+×X] . X+10; Y+11 Conditional branch depending on sign of X

120	→Y××X Continuing from line Y (if X>0) or exit	X←D0;	Y+10
	ROLL / DEAL ?		
	ROLL I DEAL ?		
121	$X[1]+?Y_{\rho}/X$ Y-shaped array of random numbers within ($X[1],X[$	X+11; 2]]	Y+11
122	?YpX Choosing Y objects out of 1X with replacement (ro		X+I
123	Y?X Choosing Y objects out of \times \text{without replacement}	X+10; (deal)	Y+10
	MATRIX INVERSION / MATRIX DIVISION		
124	*A+.×(*Y)@A+X+.*0 1 Predicted values of exponential (curve) fit	X+D1;	Y+D1
125	A+.×YEA+X+.*0 1 Predicted values of best linear fit (least square	X←D1; s)	Y+D1
126	ΦΥΞΧ·.*0,ιG G-degree polynomial (curve) fit of points (X,Y)	X+D1;	Y+D1
127	A A A[1]++A[1] A A+(@Y)@X+.*0 1 Cofficients of exponential (curve) fit of points	X+D1; (X,Y)	Y+D1
128	YEX*.*0 1 Best linear fit of points (X,Y) (least squares)	X+D1;	Y+D1
	GEOMETRICAL O		
129	$((\chi \neq 0) \times 30 Y + \chi + \chi = 0) + 0((\chi = 0) \times .5 \times \times Y) + (\chi < 0) \times 1 - 2 \times Y < 0$ Arctan $Y + \chi$	X ←D ;	; Y+D
130	1 2×.0X,Y A way to combine trigonometric functions (sin X c	X+D0, os Y)	Y+D0
131	o/-2 1,X Complementary angle (arccos sin X)		X+D0
132	2 2p1 ⁻ 1 1 1×2 1 1 20X Rotation matrix for angle X (in radians) counter-	clockw	X+D0 ise
133	X×180÷01 Transformation from radians to degrees		X+D
134	X×o÷180 Transformation from degrees to radians		X+D

	FACTORIAL / BINOMIAL !	
135	(!Y)×Y!X Number of permutations of X objects taken Y at a time	; Y+L
136	♥A・.:A+0,:X Pascal's triangle of order X (binomial coefficients)	X+10
137	+/Y×(X*A)+!A+-1+zpY X+D0; Value of Taylor series with coefficients Y at point X	Y+D1
138	$(A!X)\times(Y*A)\times(1-Y)*X-A+-\square IO-\chi X+1$	Y+D0
139	÷Y×(X-1)!Y+X-1 X+D0; Beta function	Y+D0
140	(*-Y)×(Y*X)÷!X X+I; Poisson distribution of states X with average number Y	Y+D0
141	!X-1 Gamma function	X+D0
142	Y:X Number of combinations of X objects taken Y at a time	; Y←D
	OUTER PRODUCT	
143	<pre>\dX · . = (1 1 d < \X · . = X) / X 'Position' matrix of a vector</pre>	X+D1
144	' □'[□IO+(Φ:[/A)•.≤A++/(:1+([/X)-[/X)•.=X] Histogram (distribution barchart; down the page)	X+11
145	+/((-1+Y) · . \le X) \lambda (1+Y) · . \rangle X \tag{\tau}; Distribution of X into intervals between Y	Y+D1
146	Y · . × (1+G+100) · . * X X+D; Y+D Compound interest for principals Y at rates G % in times	
147	(Y[A·.+"1+\pX]^.=X)/A+(A=1\timesX)/\pA+(1-\pX)\timesY Occurrences of string X in string Y	Y+A1
148	(1 -1 · . = \(X \) + . × \(1 \) + \(Y \) \(1 \) \(1 \) \(X \) \(1 \) \(=END)
149	0+. \((((10\times Y)\times 10-1Y+1)\cdots \) ([X\times 10\times Y) \(X\times D; \) Number of decimals (up to Y) of elements of X	Y+10
150	X+.×Y*.=((\(\rho Y\))=Y\(\rho Y\)/Y Sum over elements of X determined by elements of Y	Y+D1

151	(F A)+.×(A+((\pX)=X\X)/X)+.=X Executing costly monadic function F on repetitive argu	X←A1 ments
152	(G · .= X) + . × Y Sums according to codes G	D; G←A
153	1++/^\1 2 1 3\QY • . \neq X \\ 'X\Y' by rows for elements of matrices	; Y+A2
154	(1 10<\X+.=X)/X Removing duplicate elements (nub)	X+A1
155	[/(^/0=A+. X)/A+il/X Greatest common divisor of elements of X	X←I 1
156	+/(A×X÷[/A+Y-l/Y)•.≥-1+1X X←10 Classification of elements Y into X classes of equal s	; Y+D1 ize
157	-/(1[/,X).=QX X+12 (X[1;]=START; X[2; Transforming node matrix X into a connection matrix] = E ND)
158	^/1=+/X*.=1pX Test if X is a permutation vector	X+11
159	<pre>v/^/0 1+.=X Test if all elements of vector X are equal</pre>	X+B1
160	(pX)p(,(+/A)+.>-□IO-1 ⁻ 1†pX)\(,A+X≠' ')/,X Moving all blanks to end of each row	X+C
161	∧/,(0≠X)≤A•.≤A←11†ρX Test if X is an upper triangular matrix	X←D2
162	∧/,(0≠X)≤A+.≥A+litρX Test if X is a lower triangular matrix	X←D2
163	+f(□IO-ipX)ΦX•.×Y,0×1↓X X+D1 Product of two polynomials with coefficients X and Y	; Y+D1
164	0=(\[/X) · . X Divisibility table	X+11
165	X·.<Φι[/X Matrix with X[i] trailing zeroes on row i	X+11
166	' []'[[][O+(Φ\[/X)*.≤X] Barchart of integer values (down the page)	X+11
167	X•.≥Φι[/X Matrix with X[i] trailing ones on row i	X+11
168	X · . < \ \ \ / X Matrix with X[i] leading zeroes on row i	X←I 1

169	X+.≥ıľ/X,0 Comparison table		X←I1
170	' □'[□IO+X+.≥([/X)×(iY)÷Y] Barchart of X with height Y (across the page)	X+D1;	<i>Y</i> ←D0
171	' □'[□IO+X+.≥\[/X] Barchart of integer values (across the page)		X+I1
172	$X \cdot . \ge \iota \lceil / X$ Matrix with $X[i]$ leading ones on row i		X+I1
173	+/(\(\text{i}Y\) \cdot .=\(\(\text{i}(X-G)\digred H\) \text{X+D; } Y\digred 10; Division to Y classes with width H, minimum G	G←D0;	<i>H+</i> ⊅0
174	1 2 10X · L/X Move set of points X into first quadrant		X+D2
175	(2=+f0=(:X)+. :X)/:X All primes up to X		X+10
176	(\forall (-1+\pX)\phi(X \cdot .= Y),0)/\lambda 1+\pY Occurrences of string X in string Y	X+C1;	Y+C1
177	□10++/Y•.≥(' '=X)/1pX Ordinal numbers of words in X that indices Y point		Y+1
178	(\f(\bar{1+ip}X)\PhiX+.=Y)\fig 1 First occurrence of string X in string Y	X+A1;	Y+A1
179	Y[++Y*. \le X] Contour levels Y at points with altitudes X	X+D0;	Y+D1
180	≠/X·.≥Y Test if X is within range [Y[1],Y[2])	X+D;	Y+D1
181	+/X•.≥0 50 100 1000 Which class do elements of X belong to		X←D
182	$(((-1\Phi - A) \land A \leftarrow (-1 \downarrow X = 1 \Phi X), 0)/Y) \circ .= Y$ Repeat matrix	X←A1;	Y+A1
183	(:X) · .[:X Maximum table		X←10
184	$(,Y\cdot.>\phi(\iota G)-\Box IO)\setminus X$	Y+I1; G	G←10
185	(,Y+.>(\G)- \Box 10)\X	Y←11; G	G←10
186	((pA)pY÷100)÷A+Q1-(1+Y÷100)•.*-X Annuity coefficient: X periods at interest rate Y		Y+D

187	1 3 2 4\0X*.×Y Direct matrix product	Y+D2
188	1 2 1 20X · . ×Y Shur product X+D2;	Y+D2
189	1 2 2QY · . + X X+D1; Adding X to each row of Y	Y+D2
190	2 1 2QX+.+Y Adding X to each row of Y	Y+D2
191	1 2 1 20X · . + Y Matrix sum	Y+D2
192	1 2 1 QY + . + X Adding X to each column of Y	Y+D2
193	1 1 2QX+.+Y Adding X to each column of Y	Y+D2
194	GQX+.aY X+A; Y+A; Selecting specific elements from a 'large' outer produc	
195	(ıX)•.≤ıX X×X upper triangular matrix	X+10
196	(\X)+.≥\X X×X lower triangular matrix	01+X
197	(\times X) · . = \times X X × X identity matrix	X+10
198	+-1+(1X) · .+1X Hilbert matrix of order X	X+10
199	(\iX) • . × \iX Multiplication table	X+10
200	X[;,(Yp1)+.×1(pX)[2];] Y+10; Replicating a dimension of rank three array X Y-fold	X+43
201	(0,\(\rho X)-Y)+.+Y X+A1 Moving index of width Y for vector X	Y+10
202	X+.+1Y Indices of subvectors of length Y starting at X+1	Y+10
203	X · · · · · · 0 Reshaping numeric vector X into a one-column matrix	X ← D1
204	X+.×1 ~1 Array and its negative ('plus minus')	X+D

	INNER PRODUCT a.w		
205	(-2++/^\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		X+C2
206	((A\A)=\pA←□IO++f∧\Xv.≠QX)fX Removing duplicate rows		X+A2
207	□IO++f^\Xv.≠\Y' 'X\Y' for rows of matrices	X+A2;	Y-A2
208	(1 10<\X^.=0X)+X Removing duplicate rows		X+A2
209	(Φ∨\Φ' '∨.≠X)/X Removing trailing blank columns		X+C2
210	(v\' 'v.≠X)/X Removing leading blank columns		X+C2
211	(v\Xv.#' ')/X Removing leading blank rows		X+C2
212	(X[1+A)[1+A+(2 2p-1 1 11)+.*10*(-1+Y),-/Y+Y>99 Limits X to fit in \(\) field Y[1 2]	0 X+D	; Y+11
213	A+(X-A+L/X)[.×Y Maxima of elements of subsets of X specified by Y	X+A1	; Y+B
214	X^.=v/X Test if all elements of vector X are equal		X+B1
215	X^.=^/X Test if all elements of vector X are equal		X+B1
216	(((((1†pX),pY)†X)^.=Y)†X Rows of matrix X starting with string Y	X+A2;	Y+A1
217	(' '*X)[.×i=1+pX Indices of last non-blanks in rows		X+C
218	(A∨1+1⊕1,A+X∨.≠' ')+X Removing duplicate blank rows		X+C2
219	((-A)+X^.=(A,1+pY)pY)/1(pY)+1-A+pX Occurrences of string X in string Y	X+A1;	Y+A1
220	(Av1, 1↓A+' 'v.≠X)/X Removing duplicate blank columns		X+C2
221	~X≤.≥([X),G,H X+l0; Test if X is an integer within range [G,R)	G+10;	<i>H</i> ←10

222	YI.×X Maximum of X with weights Y	X+D1; Y+D1
223	Yl.×X Minimum of X with weights Y	X+D1; Y+D1
224	X+XL.+X Extending a distance table to next leg	X+B2
225	(Xv.*' ')+X Removing blank rows	X+C2
226	(' 'v.#X)/X Removing blank columns	X+C2
227	(X*-1+1pY)+.×ΦY Value of polynomial with coefficients Y at po	X+D0; Y+D
228	1 < X ^ . = Y Test if vector Y is a row of array X	X+A; Y+A1
229	(YA.=X):1 X+A2; First occurrence of string X in matrix Y	Y+A1; -1+pY++pX
230	X+Xv.^X Extending a transitive binary relation	X+B2
231	Xv. #Y Test if rows of X contain elements differing	X+A; Y+A0 from Y
232	X^.=Y Comparing vector Y with rows of array X	X+A; Y+A1
233	<pre>X<.<y< td=""><td>Y+D2; 1+pY ++ 2</td></y<></pre>	Y+D2; 1+pY ++ 2
234	$X < . \le Y$	Y+D2; 1+ρY ++ 2
235	(X,[.1+ppX]X)>.>Y	Y+D2; 1+pY ++ 2
236	X+.=,Y Number of occurrences of scalar X in array Y	X+A0; Y+A
237	(Y+.×X)÷pX Arithmetic average (mean value) of X weighted	X+D1; Y+D1 1 by Y
238	Y÷X Sum of alternating reciprocal series Y÷X	X+Di; Y+Di
239	Y+.÷X Sum of reciprocal series Y÷X	X+D1; Y+D1

240	X+.xY Matrix product	X←D; Y+D; ~1+pX ↔ 1+pY
241	X+.xY Summation over subsets of X specified	X+A1; Y+B
242	X+.×X Sum of squares of X	X←D1
243	Y+.×X Scalar (dot) product of vectors	X+D1; Y+D1
244	Xx.*Y Products over subsets of X specified	X+A1; Y+B
245	□RL+□TS+.*2 Randomizing random numbers (in □LX in	a workspace)
246	X+.*2 Sum of squares of X	X+D1
	SCAN W\ W\	
247	(\(\frac{1}{X}\)\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Q+11; Y+11
248	(A-L0.5×(A++/Λ\ΦA)++/Λ\A+' '=ΦX)ΦX Centering character array X with rags	X+C ged edges
249	□10++\1+((\1+/X)\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	
250	$Y[+\setminus(i+/X)\in^{-1}+i++\setminus0,X]$ Replicate $Y[i]$ $X[i]$ times (for all i)	X+11; Y+A1; ^/0 <x< td=""></x<>
251	$((X \neq 0)/Y)[+ (1+X)\epsilon + X]$ Replicate $Y[i] X[i]$ times (for all i)	X+11; Y+A1
252	<pre>#\(1+/X)&+\□IO,X Vector (X[1]p1),(X[2]p0),(X[3]p1),</pre>	X+11; A/O <x< td=""></x<>
253	$Y[\Box IO++\setminus(1+/X)\in\Box IO++\setminus X]$ Replicate $Y[i]$ $X[i]$ times (for all i)	X+11; Y+A1; ^/0 <x< td=""></x<>
254	<pre>#\Y#X\A#\1+0,A\X/#\\1+0,Y Running parity (#\) over subvectors of</pre>	X+B1; Y+B1 of Y indicated by X
255	+\Y-X\A1+0,A+X/+\-1+0,Y Cumulative sum (+\) over subvectors of	X+B1; Y+D1 of Y indicated by X
256	$Y \land A = [\X \times A \leftarrow + \Y > ^-1 \downarrow 0, Y]$ Groups of ones in Y pointed by X (or	X+B; Y+B trailing parts)

257	$A-1+0$, $A+(+\setminus X)[+\setminus Y]$	Y+11
258	$(\rho X)\rho A\setminus (A\leftarrow, \land \land (\ ' \ n' \neq X)\lor \neq \land X='''')/, X$ Decommenting a matrix representation of a function ($\Box CR$	X+C2)
259	((Φv\ΦA)^v\A+' '≠X)/X Removing leading and trailing blanks	X+C1
260	+\+\ıX X first figurate numbers	X←10
261	X^^\X=v\X First group of ones	X←B
262	<pre>(<(X=(ρX)ρ[+X)^X=Φ(ΦρX)ρ[/X)/,X Value of saddle point</pre>	X+D2
263	$((\sim(\rho A \uparrow X) \uparrow ' / ' = Y) / A \uparrow X), (1 \downarrow A \downarrow Y), (A \leftarrow + / \land \backslash Y \not = ', ') \downarrow X$ Editing X with Y ∇ -wise	Y+C1
264	$((\iota(\rho Y)++/X)\epsilon+\iota+0, -1+((\iota\rho Y)\epsilon G)\backslash X)\backslash Y$ X+11; Y+A1; Open a gap of X[i] after Y[G[i]] (for all i)	G+I1
265	$(\iota(\rho Y)++/X)\epsilon+(1+-1\downarrow0,(1\Phi Y))X$ X+I1; Insert vector for X[i] zeroes after i:th subvector	Y+B1
266	(-+/^\' '=\DX)+X Removing trailing blanks	X+C1
267	(+/^\' '=X)+X Removing leading blanks	X+C1
268	<pre>^/[Y]X=[\[Y]X Test if X is in ascending order along direction Y</pre>	Y+10
269	(-[0.5×+/^\' '=\Delta X)\Delta X Centering character array X with only right edge ragged	X+C
270	$\wedge/[Y]X=[\setminus [Y]X$	Y+10
271	$((\iota(\rho Y)++/X)\epsilon+(\iota(\iota\rho Y)\epsilon G)\backslash X)\backslash Y$	G+11
272	(\$v\\$vf' '≠X)/X Removing trailing blank columns	X+C2
273	X,[\DIO-(\tau\2\rho\72)(\rho\X),\rho\Y)/.5 0]Y Vectors as matrices in catenation	; Y+A
274	X,[\DiO+(\alpha\2\rho\7),\rho\7)/.5 1]Y Vectors as matrices in catenation	3 Y+A

275	(-+/^\' '=ΦX)ΦX Justifying right		X+C
276	(+/^\' '=X) \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		X+C
277	$(1+/X)\in (+\backslash X)-\sim \square 10$ Changing lengths of subvectors to ending indicato	rs	X←I1
278	$(1+/X)\epsilon+$ \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	tors	X+11
279	$(\iota+/A)\epsilon+ \lambda+1+\chi$ Insert vector for $\chi\{i\}$ elements before $i:th$ eleme	nt	X+11
280	(+\X)::+/X Indices of ones in logical vector X		X+B1
281	+/Y××\1,X÷i=1+pY Value of Taylor series with coefficients Y at poi	X+D0; nt X	Y+D1
282	□IO++/∧\' '≠X Indices of first blanks in rows of array X		X+C
283	(Y=+X=1+X)/X Locating field number Y starting with first element	Y+10; nt of 1	
284	$A^{-1}\downarrow 0$, $A+(Y\neq 1\downarrow Y,0)/+\backslash X$ Sum elements of X marked by succeeding identicals	X+D1; in Y	Y+D1
285	$((Y-1)+A)-0, (-Y)+A++\setminus X$ Running sum of Y consecutive elements of X	X+D1;	Y+10
286	G-T1+0,G+0[(+\Y)-X Fifo stock Y decremented with X units	Y+D1;	X+D0
287	Av-1+0,A+2 +\X='''' Locations of texts between and including quotes		X+C1
288	A^~1+0,A+2 +\X='''' Locations of texts between quotes		X+C1
289	<pre>#\(Y\X)\A*\1+0,A+(Y\X)/Y Or-scan (\(\)\) over subvectors of Y indicated by X</pre>	X+B1;	Y←B1
290	$\sim \pm \setminus (Y \le X) \setminus A \pm 1 + 0$, $A + \sim (Y \le X) / Y$ And-scan ($\land \setminus$) over subvectors of Y indicated by X	X+B1;	Y+B1
291	A-Ti+0,A+(i\psi)/+\Y Sums over (+/) subvectors of Y indicated by X	X+B1;	Y←Di
292	Y^A((X^Y)/A++\Y>-1+0,Y Groups of ones in Y pointed by X	X+B1;	Y+B1

293	Av ⁻ 1↓0,A←≠\X='''' Locations of texts between and including quotes	X+C1
294	A^-1+0,A++\X='''' Locations of texts between quotes	X+C1
295	+\('('=X)1+0,')'=X Depth of parentheses	X+C1
296	+\-1+010,X Starting positions of subvectors (lengths in X)	X←I 1
297	X[i[[\Y×ipY]] Duplicating element of X belonging to Y.1tX until	X+A1; Y+B1 next found
298	(ϕ v\ ϕ ' '*X)/X Removing trailing blanks	X+C1
299	(v\' '≠X)/X Removing leading blanks	X+C1
300	(G=+\X)/Y X+A1; G:th subvector of Y (subvectors indicated by X)	Y+B1; G+10
301	-\1X Alternating series (1 -1 2 -2 3 -3)	X←I 0
302	+\\X X first triangular numbers	X←10
303	Xv#\X Joining pairs of ones	X+B
304	v\X Turn on all zeroes after first one	X+B
305	(~X)∧≠\X Places between pairs of ones	X+B
306	^\X Turn off all ones after first zero	X+B
307	<\X Turn off all ones after first one	X←B
308	≤\X Turn on all zeroes after first zero	X+B
309	≠\X Running parity	X+B
310	+\X Cumulative sum	X+D

	REDUCTION \\ \omega \/ \omega \\ \psi \	
311	([/X)=[/X Test if all elements of vector X are equal	X+D1
312	(/X)- /X Size of range of elements of X	X+Di
313	-/×+0 10X Evaluating a two-row determinant	X+D2
314	-/×/0 10X Evaluating a two-row determinant	X+D2
315	(\(\lambda\)\v~v/X Test if all elements of vector X are equal	X+B1
316	(\(\lambda\)/X)=\(\lambda\)/X Test if all elements of vector X are equal	X+B1
317	^/X÷v/X Test if all elements of vector X are equal	X+B1
318	$(\times/(+/X+2)-0,X)*.5$ X+D1; 3 Area of triangle with side lengths in X (Heron's formul	
319	((+/(X-(+/X)+pX)*2)+pX)*.5 Standard deviation of X	X+D1
320	(+/(X-(+/X)+pX)*2)+pX Variance (dispersion) of X	X+D1
321	(+/(X-(+/X)+pX)*Y)+pX Y:th moment of X	X+D1
322	$\wedge/((1\uparrow X) \in 10 \downarrow A), X \in A \leftarrow '09AZ \triangle AX \triangle'$ Test if X is a valid APL name	X+C1
323	Y+(([-/.5×Y,pX)p''),X Centering text line X into a field of width Y	Y+10
324	^/X=1+X Test if all elements of vector X are equal	X+A1
325	(+/X)÷-1+1,pX Average (mean value) of rows of matrix X	X←D2
326	(+/X)+1+(pX),1 Average (mean value) of columns of matrix X	X←D2
327	(~1Φ1+(v/X≠~1ΘX),1)+X Removing duplicate rows from ordered matrix Y	X+A2

328	×/ ⁻ 1↓ρX Number of rows in array X (also of a vector)	X+A
329	(\(\(\tau\)\) \(\tau\) \(\tau\) Converting set of positive integers \(\tau\) into a mask	X+11
330	X:1/X Index of (first) maximum element of X	X+D1
331	[/10 Negative infinity; the smallest representable value	
332	$(+/,X)\div1\lceil\rho,X$ Arithmetic average (mean value), also for an empty array	X+D
333	$A[X] \triangle A[Y] \leftarrow 1 \triangle A \leftarrow ([/X,Y) \neq 0)$	Y+11
334	[/X,0 Positive maximum, at least zero (also for empty X)	X+D1
335	T/X Maximum of elements of X	X+D1
336	X:1/X Index of (first) minimum element of X	X+D1
337	1/10 Positive infinity; the largest representable value	
338	1/XiY Index of first occurrence of elements of Y	Y+C1
339	L/X Minimum of elements of X	X+D1
340	$0=(\rho X)^{1+}/X$ Test if all elements of vector X are equal	X+B1
341	Λ/X/1ΦX Test if all elements of vector X are equal	X+B1
342	+/Ax-1*A<1ΦA+0,1000 500 100 50 10 5 1['MDCLXVI'iX] Interpretation of roman numbers	X÷A
343	^/X=1ΦX Test if all elements of vector X are equal	X+A1
344	A/X=10X Comparison of successive rows	X+A2
345	\(\lambda(\chi\chi),\chi\chi\) Identity of two sets	Y+A1

346	^/(ipX)∈X Test if X is a permutation vector	X+11
347	★/0 1∈X Test if all elements of vector X are equal	X←B1
348	v/YeX Test if X and Y have elements in common	X+A; Y+À1
349	~^/X&~X Test if all elements of vector X are equal	X+B1
350	^/,X∈0 1 Test if X is boolean	X←A
351	^/Y∈X Test if Y is a subset of X (Y = X)	X+A; Y+A1
352	≠/0 1∈X Test if all elements of vector X are equal	X+B1
3 5 3	A/(X:X)=:pX Test if each element of X occurs only once	X+A1
3 5 4	^/DIO=X1X Test if all elements of vector X are equal	X+A1
355	~v/X None, neither	X←B
356	V/X Any, anyone	X←B
357	<pre>^/,X=Y Test if arrays of equal shape are identical</pre>	+A; ρX ↔ ρY
358	^/X=X[1] Test if all elements of vector X are equal	X+A1
359	^/' '=X Blank rows	X+C2
360	A/X All, both	X←B
361	≠/X Parity	X÷B
362	+/X=,Y Number of occurrences of scalar X in array Y	X+A0; Y+A
363	$(-X[2]-1 1\times((X[2]*2)-\times/4,X[1 3])*.5)+2\times X[1]$ (Real) solution of quadratic equation with coeff	

364	(+/[Y]X)÷(pX)[Y] Average (mean value) of elements of X along direct	X+D; ion Y	Y+10
365	(+/X)+pX Arithmetic average (mean value)		X+D1
366	×/pX Number of elements (also of a scalar)		X+A
367	÷/X Alternating product		X←D
368	×/X Product of elements of X		X+D1
369	-/X Alternating sum		X+D
370	+/X Number of elements satisfying condition X		X+B1
371	+/X Reshaping one-element vector X into a scalar		X+A1
372	+†X Column sum of a matrix		X+D2
373	+/X Row sum of a matrix		X+D2
374	+/X Sum of elements of X		X+D1
	TAKE †		
375	Y[iG;],[i]((i+pY)+X),[i](2+G)+Y X+A1; Inserting vector X into matrix Y after row G	Y+A2;	G+10
376	(AtX),[11](1+A+(pX)[0,pY)tY Inserting vector Y to the end of matrix X	X+A2;	Y+A1
377	YtX,Yp-1tX Filling X with last element of X to length Y	X+A1;	Y+10
378	X[Y;]+(1+pX)+D Input of row Y of text matrix X	X+C2;	Y+10
379	(1+A)+(A+1ΦA+X=Y)/X Removing leading, multiple and trailing Y's	X-A1;	Y+40
380	$X+(\rho X)\rho A$ Δ $A[(A=1+Y)/1\rho A+,X]+1+Y$ Changing elements in X with value Y[1] into Y[2]	X+A;	Y+A1

		No.
381	X>((-ppX)+-1)+0,X First ones in groups of ones	X←B
382	(GtY), X, G+Y Inserting X into Y after index G	; Y+A1; G+I0
383	X-((-ρρX)+-1)+0,X Pairwise differences of successive columns (inver	X+D *se of +\)
384	((-ppX)+1)+X,0 Rightmost neighboring elements	X+D
385	((-ppX)+-1)+0,X Leftmost neighboring elements	X←D
386	(-pX)+(-Y)+X Shifting vector X right with Y without rotate	X+A1; Y+10
387	(pX)†Y‡X Shifting vector X left with Y without rotate	X+A1; Y+10
388	(2+Y)+X Drop of Y first rows from matrix X	X-A2; Y+10
389	,Q(Ap2)p(2*A+[2•X)+iX Playing order in a cup for X ranked players	X+10
390	((1 0×pY)[pX)†X Lengthening matrix X to be compatible with Y	X+A2; Y+A2
391	((O 1×pY)[pX)+X Widening matrix X to be compatible with Y	X+A2; Y+A2
392	(1[-2†pX)pX Reshaping non-empty lower-rank array X into a mat	X+A; 2≥ppX rix
393	(-L.5×Y+pX)+X Centering text line X into a field of width Y	X+C1; Y+10
394	(XLpY)†Y Take of at most X elements from Y	X+1; Y+A
395	(TitpY)](,Y);X Alphabetizing X; equal alphabets in same column of	Y+C2; X+C
396	(~(i~1+pX)∈Y)/X Removing columns Y from array X	X+A; Y+I1
397	(~1†(' '≠X)/\pX)pX Removing trailing blanks	X+C1
398	(1-1-1+pX) ΦX Aligning columns of matrix X to diagonals	X+A2

399	(-1+1-1+pX) ΦX Aligning diagonals of matrix X to columns	X ← A2
400	OcitopX Test if numeric	X+A
401	("1+X1' ')†X First word in X	X+C1
402	(-2+i i,pX)pX Reshaping non-empty lower-rank array X into a mat	X÷A; 2≥ppX rix
403	itm,X Giving a character default value for input	X+C0
404	(X×Y)p(-Y)+1 Ending points for X fields of width Y	X+10; Y+10
405	(X×Y)pY†1 Starting points for X fields of width Y	X+10; Y+10
406	$X+(-\rho X)+Y$ Adding scalar Y to last element of X	X+D; Y+D0
407	YtXp1 Vector of length Y with X ones on the left, the r	X+10; Y+10 est zeroes
408	1 80p80†X Forming first row of a matrix to be expanded	X+A1
409	1+0pX Zero or space depending on the type of X (fill el	X+A ement)
410	TitpX Number of columns in matrix X	X←A2
411	1tpX Number of rows in matrix X	X+A2
412	(-Y)+X Transferring text X to right edge of field of wid	Y+10; X+C1
	DROP +	
413	$(1 \downarrow A) = 1 \downarrow A \leftarrow (A, 1) / i + pA \leftarrow 1, (1 \downarrow X) \neq -1 \downarrow X$ Lengths of subvectors with equal elements	X+A1
414	$G^{-1}\downarrow 0$, $G\leftarrow (\sim \square IO)+(((1\downarrow X)\neq ^-1\downarrow X),1)/1pX$ Field lengths of vector X; $G \leftrightarrow$ ending indices	X+A1; G+I1
415	$(A>0)/A \leftarrow (1+A)-1+^{-1}+A \leftarrow (\sim A)/\log A \leftarrow 0$, X, 0 Lengths of groups of ones in X	X+B1

416	((A:1)-□IO)+(□IO-(ΦA←~X∈Y):1)+X Removing elements Y from beginning and end of vector	X+A1; Y+A or X
417	((1↓X)≠ ⁻ 1↓X),1 Ending points of equal groups	X←A1
418	1,(1↓X)≠ ⁻ 1↓X Starting points of equal groups	X+A1
419	$(1 \downarrow X) \div^- 1 \downarrow X$ Pairwise ratios of successive elements of vector X	X+D1
420	(1↓X)- ⁻ 1↓X Pairwise differences of successive elements of vect	or X
421	$(Y \land X) \lor (Y \lor X) \land A \gt 1 \downarrow 0, A \leftarrow (Y \lor X)/Y$ First ones of subvectors of Y indicated by X (<\)	(+B1; Y+B1
422	(~1Φ1+(X≠~1ΦX),1)/X Removing duplicates from an ordered vector	X+A1
423	A-~1+0,A+(1ΦX)/ιρX Changing starting indicators of subvectors to lengt	X+B1
424	(A∨1+1Φ1,A+' '≠X)/X Removing multiple blanks	X+C1
425	(pX)pA \(A \) A[(A=1pY)/\(\text{1pA+, X}\) +1+Y \\ Replacing all values Y[1] by Y[2] in X	; 2 ↔ pY
426	(Av~1↓1,A←X≠Y)/X Removing duplicate Y's from vector X	(+A1; Y+A0
427	(□IO→(~ΦX∈Y)\1)+X Removing elements Y from end of vector X	X+A1; Y+A
428	(1-(Φ' '≠X):1)↓X Removing trailing blanks	X+C1
429	0 -1+(-ιρΧ)Φ((2ρρΧ)ρ0),X Diagonal matrix with elements of X	X←D1
430	T1+X×ΦT1+tpX Derivate of polynomial X	X+D1
431	$(-1 \downarrow X \neq 1 \Phi X)$, 1 Test if an element differs from the next one	X+A1
432	1,1\X≠ ⁻ 1ΦX Test if an element differs from the previous one	X+A1
433	1Φ ⁻ 1↓Y,X Replacing last element of X with Y	Y+A1; Y+A0

434	TiΦi+X,Y Replacing first element of X with Y	X+A1;	Y+40
435	(((~X∈Y)\1)-□IO)↓X Removing elements Y from beginning of vector X	X+A1	Y+A
436	X-(-Y=1ppX) \$0,[Y]X Differences of successive elements of X along dire	X+D; ection	
437	(~1+(X='0'):0)↓X Removing leading zeroes		X+A1
438	Y+(Y+X):1 Index of first one after index Y in X	G+10;	X+B1
439	X>1+X,0 Last ones in groups of ones		X+B1
440	X>-1+0,X First ones in groups of ones		X+B1
441	1+,',',X List of names in X (one per row)		X←C2
442	X-~1+0,X Restoring argument of cumulative sum (inverse of	+\)	X+D1
443	(0,Y)+X Drop of Y first columns from matrix X	X+A2	Y+10
444	(Y,0)↓X Drop of Y first rows from matrix X	X+A2;	Y+10
445	1+pX Number of columns in matrix X		X+A2
446	Ti+pX Number of rows in matrix X		X+A2
447	(Y×G)+X X+A; Conditional drop of Y elements from array X	Y+/1;	G+B1
448	(-Y)+X Conditional drop of last element of X	X+A1;	Y+80
	CEILING / MAXIMUM [
449	Y[1][Y[2] X Limiting X between Y[1] and Y[2], inclusive	X+D;	Y+D1

450	10@ 1-3×÷3 Arithmetic precision of the system (in decimals)	
451	$X+(G\times Y-X)\times \{i+ i(Y-X)+G\}-\Box IO$	G+D0
452	1+(X<0)+l10@ X+0=X Number of digitpositions in integers in X	X+I
453	LX+1<2 X Rounding to nearest even integer	X+D
454	<pre>LX+.5×.5≠2!X Rounding, to nearest even integer for .5 = 1 X</pre>	X+D
455	1+[10+(X=0)+X×1 -10[1+X<0] Number of digit positions in integers in X	X←I
456	1+l10eX+0=X Number of digits in poșitive integers in X	X+I
457	X=LX Test if integer	X+D
458	$(X,G)[(1+\rho X)[Y]$	G+A0
459	LX+1000 First part of numeric code ABBB	X←I
460	(10*-X)×L0.5+Y×i0*X Rounding to X decimals	; Y←D
461	0.01×10.5+100×X Rounding to nearest hundredth	X+D
462	l0.5+X Rounding to nearest integer	X+D
	MAGNITUDE / RESIDUE	
463	(0=400 X)∨(0≠100 X)∧0=4 X Test if X is a leap year	X+1
464	'_',[1](' ',X,' '),[1]'"' Framing	X+C2
465	111X Magnitude of fractional part	X+D
466	(0≠Y \pX)/X X+A1; Removing every Y:th element of X	Y←10

467	(0=Y 1pX)/X Taking every Y:th element of X	X+A1; Y+10
468	(0=A X)/A+1X Divisors of X	X+10
469	(2 1pX)/X Removing every second element of X	X+A1
470	(0=Y X)/X Elements of X divisible by Y	X+D1; Y+D0 or D1
471	□IO+(pX) Y+(YΦX)\G Index of first occurrence of G in X (circula	X+A1; Y+I0; G+A arly) dfter Y
472	(1+pY) YiX Changing index of an unfound element to zero	Y+A1; X+A
473	~2 X Test if even	X+1
474	X×Y≤ X Rounding to zero values of X close to zero	X+D; Y+D
475	(×X)×Y+ X Increasing absolute value without change of	X+D; Y+D sign
476	(×X) X Fractional part with sign	X+D
477	X× X Square of elements of X without change of s	X+D ign
478	ilX Fractional part	X+D
479	10001X Last part of numeric code ABBB	X+1
	EXPAND \	
480	A\(A+~X&Y)/X Replacing elements of X in set Y by blanks	X+A0; Y+A1 / zeroes
481	A\(A+X\in Y)/X Replacing elements of X not in set Y by bla	X+A1; Y+A nks / zeroes
482	$A \triangle A[(\sim G)/\iota \rho G]+Y \triangle A+G\backslash X$ Merging X and Y under control of G (mesh)	X+A1; Y+A1; G+B1
483	Y\Y/X Replacing elements of X not fulfilling Y by	X+A; Y+Bi blanks / zeroes

484	Φα\ΦX Scan from end with α		X+A
485	(~(\(\rho Y) + 1\rho X) \(\epsilon Y + \(\rho Y) \) \(\frac{1}{2} \) Adding an empty row into X after rows Y	X+A2;	Y+I1
486	0 < 0 \ 0 p X Test if numeric		X+A1
487	((Y+1) #11+1ppX) \X Adding an empty row into X after row Y	X+A2;	Y#10
488	X,[\(\frac{1}{0}\)1\(\frac{1}{1}\)'\'\'\'\'\'\'\'\'\'\'\'\'\'\'\'\'\'\'		X+Ci
489	(pY)p(,Y)\X Using boolean matrix Y in expanding X	X+A1;	Y+B2
490	((2×pX)p1 0)\X Spacing out text		X+C1
	COMPRESS /		
491	$(X/Y) \ge A/1 \Phi A \leftarrow (Y \lor X)/X$ Or-reduction $(\lor I)$ of subvectors of Y indicated by	X←Bi; X	Y+B1
492	$(X/Y) \land A/1 \Phi A + (Y \le X)/X$ And-reduction (\(\lambda/\)) of subvectors of Y indicated by	X+B1; y X	Y+B1
493	(G/X),(~G)/Y X+C1; Choosing a string according to boolean value G	Y+C1;	G+80
494	(A∨1ΦA←X≠' ')/X (Cyclic) compression of successive blanks		X+C1
495	$(X \in Y)/1 pX$ Indices of all occurrences of elements of Y in X	X+A1;	Y+A
496	(~X&' .,:;?''')/X Removing punctuation characters		X+A1
497	Y,(~XeY)/X Union of sets, u	X+A1;	Y+A1
498	$(\sim X \in Y)/X$ Elements of X not in Y (difference of sets)	X+A1;	Y+A
499	$(X[;1] \in Y) \neq X$ Rows of non-empty matrix X starting with a charact	X+A2; er in	
500	(XeY)/X Intersection of sets, n	X+A1;	Y+A

501	((X:X)=:pX)/X Removing duplicate elements (nub)	X ← A1
502	((pX)*Y*ippX)p a/[Y]X Y+10 Reduction in dimension Y, rank unchanged	; X+A
503	(Y=X)/lpX X+A1; Indices of all occurrences of Y in X	Y+40
504	Y[X/lpY]+G Replacing elements of Y satisfying X with G Y+A1 X+B1	G+A0
505	A/19999 \(A[X]+1 \(\Delta A+999990 \) Removing duplicates from positive integers	X+11
506	X/tpX Indices of ones in logical vector X	X+B1
507	(,X,[1.5]1)/,X,[1.5]~X Vector to expand a new element after each one in X	X+B1
508	((~X)/'IN'),'CORRECT' Conditional in text	X+B0
509	(X = Y) / X Removing elements Y from vector X	Y+40
510	(' '≠X)/X Removing blanks	X+A1
511	a/,X Reduction with a without respect to shape	X+D
512	Y/X Selecting elements of X satisfying condition Y	Y+B1
513	O+X Empty matrix	X+A2
	TRANSPOSE &	
514	QFQX Applying to columns function F defined on rows	Y+10
515	((\Phi A) x 1, Y) \rho 2 1 3\Phi(1\Phi Y, A+(\rho X) \div 1, Y) \rho X X+A2; **Transpose* of matrix X with column fields of width Y	G+10
516	X×Q(ΦρX)ρY X+D2; Multiplication of each column of matrix X by vector Y	Y+D1
517	\(\phi(\phi\po Y)\rho X\) Matrix with shape of Y and X as its columns	Y+A2

518	(Y\$1 2)&X Transpose matrix X on condition Y	X+A2; Y+B0
519	~0 < X = - QX Test for antisymmetricity of square matrix X	X+D2
520	~0 < X=QX Test for symmetricity of square matrix X	X-42
521	Φ(X,ρY)ρY Matrix with X columns Y	X+10; ¥#D\$
522	1 iqX[Y[1;];Y[2;]] Retrieving scattered elements Y from matrix X	X+A2; Y+12
523	X[Y]QG Successive transposes of G (X after Y: XQYQG)	X+11; Y+11
524	40 120p2 1 3010 40 12pX Dividing a 400×12 character matrix into one page	X+G2
525	(1*pX)QX Main diagonal of array X	X+A
526	1 10X Diagonal elements of matrix X	X+A2
527	1 3 20X Transpose of planes of a rank three array	X+A3
	REVERSE / ROTATE • •	
528	REVERSE / ROTATE • • ((10X)×10Y)-(-10X)×10Y Vector (cross) product of vectors	X+D; Y+D
	((1\psi x) \times 1\psi Y) - (\frac{1}{2}\psi x) \times 1\psi Y	X+D; Y+D X+A1; Y+I1
529	((1\phiX)\times^1\phiY)-(\sum_1\phiX)\times1\phiY Vector (cross) product of vectors 1\phi(\tipX)\in Y	
529	((1\PhiX)x^1\PhiY)-(^1\PhiX)x1\PhiY Vector (cross) product of vectors 1\Phi(\pi\pi)\in Y Ending points for X in indices pointed by Y (^1 1[2x\Pii]\Phi)-(\PhiX)\piY	X+A1; Y+I1
529 530 531	((1\phiX)\times^1\phiY)-(^1\phiX)\times1\phiY Vector (cross) product of vectors 1\phi(\tipX)\in Y Ending points for X in indices pointed by Y (^1 1[2\times[10]+\piX)-(\phiX)\timesY Index of last element of Y in X (1+\piX)-(\phiX)\timesY	X+A1; Y+I1 X+A1; Y+A0
529 530 531	((1\phiX)x^1\phiY)-(^1\phiX)x1\phiY Vector (cross) product of vectors 1\phi(\text{to}X)\in Y Ending points for X in indices pointed by Y (^1 1[2x\product]0]+pX)-(\phiX)\text{t}Y Index of last element of Y in X (1+pX)-(\phiX)\text{t}Y Index of last occurrence (\phiX)\text{t}Y	X+A1; Y+I1 X+A1; Y+A0 X+A1; Y+A

535	(01,)←E Avoiding parentheses with help of reversal	EXPRESSION
536	10X Rightmost neighboring elements cyclically	X+A
537	~10X Leftmost neighboring elements cyclically	X+A
	MEMBER OF €	
538	~(\(\(\rho Y\))+\(\rho X\)\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	(+A1; Y+I1
539	(~(\Y)&X) Boolean vector of length Y with zeroes in locations	X+1; Y+10 x X
540	(tpX) EY Starting points for X in indices pointed by Y	(+A1; Y+I1
541	(XcY)×YtX Changing index of an unfound element to zero (not e	X+A; Y+Ai effective)
542	(Y+□)∈\X Check for input in range 1X	X+A
543	(\Y)∈X Boolean vector of length Y with ones in locations }	X+1; Y+10
544	~0 < X=Y Test if arrays are identical	X+A; Y+A
545	Yx~Y&X Zeroing elements of Y depending on their values	Y+D; X+D
546	1cp,X Test if single or scalar	X+A
547	leppX Test if vector	X+A
548	θερχ Test if X is an empty array	X+A
	INDEX GENERATOR / INDEX OF 1	
549	(G:X) <g:y alphabetical="" alphabets="" comparison="" g<="" td="" with=""><td>X+A; Y+A</td></g:y>	X+A; Y+A
550	XiipX Inverting a permutation	X+11

551	(Y = X):1 X+A1; Index of first differing element in vectors X and Y	Y+A1
552	(\(\frac{1}{0}\) \(\rho_Y\) = Y\\ \(\chi_X\) \(\rho_X\)	
553	A \(A[X] + A \(\Delta A + \cdot \rho X \) Inverting a permutation	¥+11
554	G[Y:X;] X+D; Y+D1; Changing numeric code X into corresponding name in Y	G+02
555	lppX All axes of array X	X+A
556	tpX All indices of vector X	X+A1
557	X+G×(\(\tau\)-\(\tau\)) X+D0; Y+D0; Arithmetic progression of Y numbers from X with step G	G+D0
558	(X-DIO)+11+Y-X X+IO; Consecutive integers from X to Y (arithmetic progression	
559	-Xii Index of first satisfied condition in X	X+B1
560	li Index origin (□IO) as a vector	
561	DAVIX Converting characters into numeric cades	X+A
562	X:Y Index of key Y in key vector X	K+4
563	tO Empty numeric vector	
	LOGICAL ~ V A + +	
564	<pre>(Y[1]<x)^x<y[2] (="")<="" if="" is="" pre="" range="" test="" within="" x="" y[1],y[2]=""></x)^x<y[2]></pre>	Y+D1
565	(Y[1]≤X)∧(X≤Y[2])	2=pY
566	0^X Zeroing all boolean values	X←B
567	(X×G)+Y×~G X+D; Y+D; Selection between Y and Y depending on condition G	G+B

568	(~□IO)+X Changing an index origin dependent result to	be as DIO=1
569	Y*~X Conditional change of elements of Y to one ac	Y+D; X+B cording to X
	COMPARISON < ≤ = ≥ > ≠	
570	X≤Y X implies Y	X+B; Y+B
571	X>Y X but not Y	X+B; Y+B
572	(0≠X)×Y+X+0=X Avoiding division by zero error (gets value z	X+D; Y+D ero)
573	X=Y Exclusive or	X+B; Y+B
574	X+Y×X=0 Converting zeroes to Y	X+D; Y+D
575	Y=X Kronecker delta of X and Y (element of identi	X+I; Y+I ty matrix)
	RAVEL / CATENATE ,	
576	,(((pX),Y)pG),X X Catenating Y elements G before every element	+A1; Y+10; G+A0 of X
577	,X,((pX),Y)pG Catenating Y elements G after every element o	X+A1; Y+10; G+A f X
578	,Y,[[]10+.5]X Merging vectors X and Y alternately	X+A1; Y+A1
579	X,OTC[2],Y Separating variable length lines	X+A1; Y+A1
580	,X,[1.1]' ' Spacing out text	X+C1
581	,X,[1.1]Y Inserting Y after each element of X	X+A1; Y+A0
582	(X,X)p1,Xp0 X×X identity matrix	X+10
583	X,[.5+ppX]-X Array and its negative ('plus minus')	X←D

584	$X+(\rho X)\rho A$ \triangle $A[G]+Y$ \triangle $A+\gamma X$ Temporary ravel of X for indexing with G	X+A; Y+A; G+I
585	$X+A\rho X \Delta X[G]+Y \Delta X+,X \Delta A+\rho X$ Temporary ravel of X for indexing with G	X+A; Y+A; G+I
586	X,[[][O1]'-' Underlining a string	X+C1
587	X[;,1] First column as a matrix	X+A2
588	X,[.1]Y Forming a two-row matrix	X+A1; Y+A1
589	X,[1.1]Y Forming a two-column matrix	X+A1; Y+A1
590	((((ppX)-ppY)p1),pY)pY Increasing rank of Y to rank of X	X+A; Y+A
591	((0.5×pX),2)pX Reshaping vector X into a two-column matrix	X+A1
592	(pX)p ,X X+A; Handling array X temporarily as a vector	+EXPRESSION
593	(Y, pX) pX Forming a Y-row matrix with all rows alike (X)	X+A1; Y+10
594	((pX),1)pX Reshaping vector X into a one-column matrix	X+A1
595	(1,pX)pX Reshaping vector X into a one-row matrix	X ← A1
596	p,X Number of elements (also of a scalar)	X+A
597	Y,0pX Joining sentences	X+A; Y+A1
598	X+0 2 1 2 5 8 0 4 5, Entering from terminal data exceeding input (pr	X←D rinting) width
-	AXIS / INDEXING [
599	(pX)[ppX] Number of columns in array X	X+A
600	(pX)[2] Number of columns in matrix X	X←A2

601	(pX)[1] Number of rows in matrix X	X+A2
602	Y[2+×X] Choosing according to signum	X+D; Y+A1
603	Y×1 -1[1+X] Conditional elementwise change of sign	Y+D; X+B
604	X[2×010] Selection depending on index origin	X+A1
605	' *'[□10+X] Indexing with boolean value X (plotting a curve)	X+B
606	X[[]10+Y] Indexing independent of index origin	X+A1; Y+1
607	X[;1] First column as a vector	X+A2
608	X[]+0 Zeroing a vector (without change of size)	X+D1
609	X[1] Selection depending on index origin	X+A1
	SHAPE / RESHAPE P	
610	(Y×pX)pX Duplicating vector X Y times	X+A1; Y+70
611	$X \times (\rho X) \rho Y$ Multiplication of each row of X by vector Y	X+D; Y+D1
612	ppX Rank of array X	X+A
613	1ppX Number of rows in matrix X	X+A2
614	(pY)pX Array with shape of Y and X as its rows	X+A1: Y+A
615	1pX Corner element of a (non-empty) array	X+A
616	''pX Reshaping X into a scalar	X←A
617	0pX← Output of an empty line	X←A

618	0 80p0 Forming an initially empty array to be expanded	
	ARITHMETIC + - × +	
619	1++2++3++4++5++6 Continued fraction	
620	Yx+X Force 0+0 into DOMAIN ERROR in division	D
621	i Ti×X Number and its negative ('plus minus')	0
622	$Y \times X$ $X \leftarrow D; Y \leftarrow Selecting elements satisfying condition Y, zeroing others$	₿
623	X×-i*Y Conditional elementwise change of sign	Y
624	0×X Zero array of shape and size of X	D
625	-DIO-X Changing an index origin dependent result to be as DIO=0	I
626	(□10-1)+X Changing an index origin dependent argument to act as □10=1	-
627	+X← Output of assigned numeric value	D
628	□IO+X Changing an index origin dependent argument to act as □IO=0	
	MISCELLANEOUS	
629	* Syntax error to stop execution	
630	□+X+ Output of assigned value	4
631	□LX←T Setting latent expression	

SYNONYM LIST

Adding X to each column of Y

193 1 1 2 X . + Y

192 1 2 1 QY . . + X

Adding X to each row of Y

190 2 1 20% .. + Y

189 1 2 20Y · . + X

Arithmetic average (mean value)

365 (+/X)+pX

332 (+/,X)+1[p,X

Ascending cardinal numbers (ranking)

1 [.5×(AAX)+ΦAAΦX

13 AAX

Centering text

323 $Y+((1-/.5\times Y, \rho X)\rho''), X$

393 $(-1.5 \times Y + \rho X) + X$

269 (-L0.5x+/^\' '=\$X)\$X

248 (A-[0.5×(A++/^\ΦA)++/^\A←' '=ΦX)ΦX

Changing index of an unfound element to zero

472 (1+pY) | Y1X

541 (XeY)×YiX

Conditional elementwise change of sign

603 Y×1 T1[1+X]

623 X×-1*Y

Diagonal elements of matrix X

526 1 1 QX

525 (1*pX) QX

Drop of Y first rows from matrix X

444 (Y,0)+X

388 (2+Y) \X

Evaluating a two-row determinant

314 -/×/0 19X

313 -/×+0 1ΦX

Expansion vector with zero after indices Y

27 (pX)≥4(tpX),Y

538 ~(1(pY)+pX) & Y+1 pY

First ones in groups of ones

381 X>((-ppX)+-1)+0,X

440 X> 140, X

Giving a default value for input

97 1p(±0,',10'),X

403 1 + 11 × X

Index of (first) maximum element of X

23 T1+AX

330 X1 / X

Index of (first) minimum element of X

22 1 † AX

336 X11/X

Indices of ones in logical vector X

41 (+/X)+\X

280 (+\X)11+/X

506 X/1pX

Inverting a permutation

37 AX

553 A ∆ A[X]+A ∆ A+1pX

550 ΧιιρΧ

Locations of texts between and including quotes

```
287 Av-1+0,A+2|+\X=''''
293 Av-1+0,A+*\X=''''
```

Locations of texts between quotes

Merging (mesh)

```
482 A A A[(~G)/1pG]+Y A A+G\X
```

- 12 (X,Y)[AAG]
- 16 (Y, X)[AVG]
- 31 A & A[AG]+A+Y,X
- 11 $(Y,X,Z,...)[\Delta\Delta G]$

Number and its negative ('plus minus')

```
621 1 T1 × X
```

583 X,[.5+ppX]-X

204 X+.×1 -1

Number of columns in matrix X

600 (pX)[2]

410 Ti+pX

445 1+pX

599 (pX)[ppX]

Number of elements (also of a scalar)

596 p.X

Number of occurrences of scalar X in array Y

236 X+.=,Y

362 + /X = , Y

Number of rows in matrix X

601 (pX)[1]

411 1 tpX

613 1ppX 446 1+pX

Occurrence(s) of string X in string Y

178' (^f(-1+ιρΧ)ΦΧ·.=Y)τ1

 $147 \quad (Y[A \cdot .+ T+1 + 1 \rho X] \land .= X)/A + (A=1+X)/1 \rho A + (1-\rho X) + Y$

219 $((-A)+X\wedge = (A,1+\rho Y)\rho Y)/\iota(\rho Y)+1-A+\rho X$

Output of assigned value

630 U+X+

627 +X+

Removing duplicate elements

501 $((XtX)=t\rho X)/X$

 $154 (1 10 < X \cdot , = X) / X$

505 A/19999 A A[X]+1 A A+9999p0

 $422 \quad (-101+(X=-10X),1)/X$

Removing duplicate rows

70 $((A : A) = : \rho A + 2 \perp X \wedge . = \emptyset X) \neq X$

208 (1 1 $0 < X = 0X) \neq X$

327 $(-101+(\sqrt{X}),1)+X$

206 $((A \wr A) = \iota \rho A + \square IO + + f \wedge \lambda X \vee * \Rightarrow \phi X) \neq X$

Removing leading blanks

267 (+/^\' '=X)+X

299 (v\' '#X)/X

Removing trailing blanks

298 (**Φ∨\Φ' "**≠X)/X

73 (1-(' '=X)±1)+X

397 ("1+(' '*X)/1pX)pX

428 (1-(Φ' '≠X):1)+X

266 (-+/^\' '=\X)+X

Removing trailing blank columns

272 (\$\\\$\\+' '\\\X\)/X

209 (Φ∨\Φ' 'v.≠X)/X

4 5 24

Replicate Y[i] X[i] times (for all i)

250 $Y[+(1+/X)e^{-1}+1++(0,X]$

251 $((X \neq 0)/Y)[+ (1+X)\epsilon + X]$

253 $Y[\Box IO++\setminus(\iota+/X)\in\Box IO++\setminus X]$

Representations of current date

107 A ∆ A[(' '=A)/\pA]+'/' ∆ A+∓100|1\$3†□TS

65 A A A[5 8]+'-' A A+*1000±3+0TS

104 A ∆ A[(' '=A)/1ρA]+'.' ∆ A+∓Φ3+□TS

72 100110013+DTS

Representations of current time

64 A ∆ A[3 6]+':' ∆ A+∓1000±3+3+□TS 105 (,(0 1+3 0¥100+3 1ρ12 0 0[3+3+□TS),':: '),'AP'[1+12≤□TS[4]],'M'

Reshaping non-empty lower-rank array X into a matrix

392 (1[-2+pX)pX 402 (-2+i 1*pX)pX

Reshaping vector X into a one-column matrix

203 X . . + , 0

534 (Φ1, pX) pX

594 ((pX),1)pX

Selection depending on index origin

604 X[2×DIO]

609 X[1]

Sorting rows of matrix X into ascending order

9 $(\rho X) \rho (, X) [A[A(, \Phi(\Phi \rho X) \rho i 1 \uparrow \rho X) [A + A, X]]]$

8 $(\rho X)\rho(,X)[\Box IO+A[A[A+Ti\uparrow\rho X]]$ Δ $A+(A,X)-\Box IO$

Spacing out text

580 ,X,[1.1]' ' 490 ((2×pX)p1 0)\X

Temporary ravel of X for indexing with G

ì

1

Test for symmetricity of matrix X

Test if all elements of vector X are equal

* 4 * 1 * 4 * 1

```
\wedge/X=X[1]
358
     \wedge/X=1\Phi X
343
340
     0=(\rho X)|+/X
159
     v/^/0 1 · . = X
     ^/X=1 †X
324
     (\Lambda/X)v\sim V/X
315
311 ([/X)=L/X
317
     ^/X÷v/X
352
    ≠/0 1∈X
    (∧/X)=v/X
316
347 #/0 1ex
215 XA.=A/X
214
     X^.=v/X
341
     A/X/1 ΦX
354
     A/DIO=XXX
349 ~^/XE~X
```

Test if arrays of equal shape are identical

357 $\wedge /, X=Y$ 544 $\sim 0 \in X=Y$

Test if numeric

400 0 € 1 † 0 p X 486 0 € 0 \ 0 p X

Test if X is a permutation vector

Value of polynomial with coefficients Y at point X

227 (X*⁻1+ιρΥ)+.×ΦΥ 83 ΧιΥ 69 (X·.+,0)ιΥ

Value of Taylor series with coefficients Y at point X

137 +/Y×(X*A)+!A+-1+ipY 281 +/Y××\1,X+i-1+pY

Vectors as matrices in catenation

273 $X,[\Box IO-(+\backslash 2p \land /2>(ppX),ppY)/.5 0]Y$ 274 $X,[\Box IO+(+\backslash 2p \land /2>(ppX),ppY)/.5 1]Y$

X×X identity matrix

197 (ιχ)·.=ιχ 582 (χ,χ)ρ1,χρ0

PERMITTED INDEX

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